4.10 Renewable Hydrogen Production for Fossil Fuel Processing

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Abstract

This applied photosynthesis research project is focused on the production of renewable hydrogen by light-activated water splitting. Photosynthesis is the fundamental biological process that converts solar energy into stored chemical energy. In the normal photosynthetic process, atmospheric carbon dioxide is converted into stable energy-rich carbon compounds. The source of reductant for this process is water and the oxidation product is molecular oxygen. Oak Ridge National Laboratory was the first to show that unicellular microalgae can split water into elemental hydrogen and oxygen. This process is strictly analogous to the electrolysis of water except that the source of energy needed to drive the endothermic reaction is visible light not electricity.

The great potential of hydrogen production by microalgal water splitting is predicated on quantitative measurement of the algae's hydrogen-producing capability, which is based on the following: (1) the photosynthetic unit size of hydrogen production; (2) the turnover time of photosynthetic hydrogen production; (3) thermodynamic efficiencies of conversion of light energy into the Gibbs free energy of molecular hydrogen; (4) photosynthetic hydrogen production from sea water using marine algae; (5) the potential for research advances using modern methods of molecular biology and genetic engineering to maximize hydrogen production.

Measurements of the absolute yield of hydrogen production following single turnover saturating flashes of light in mutant Fud26 of *Chlamydomonas reinhardiii* have been performed. Our data indicate that the Z-scheme, the standard model of photosynthesis, cannot account for the amount of hydrogen produced per flash. This result is interesting both from an applied and scientific point of view. Hydrogen production by a single light reaction is, in principle, more efficient that a process requiring two light reactions. Scientifically, the data suggest a non-Z-scheme photosynthetic pathway.

Publications

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